Postbinary Supersensory Computer: Information Storage and Computing in View of the Measurement Accuracy

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The concept of postbinary supersensory computer and its implementation in the form of an experimental prototype are considered. Supersensory computer (SSC) is an intelligent sensor device, which includes a large number of miniature sensors, microprocessor, memory and communications interfaces. Features and characteristics of the developed prototype, including the case of storage and computational processing of sensory information with regard to real accuracy are analyzed. Postbinary supersensory computer (PSSC) means, that the representation, storage, and usage in subsequent calculations of the measured values use postbinary data formats.

Introduction

The concept of supersensory computer (SSC) was first formulated by the authors in 2012 [1] and it is the result of search for further ways of effective modern computing development [2, 3]. This direction is a continuation and development of research in the field of computer monitoring systems and high-performance information and simulation environments for research, development and maintenance of complex dynamical systems [4], maintained by the Department of Computer Science and Technology in Donetsk National Technical University.

One of the most actual contemporary problems, which solution can be deployed by supersensory computers, is the pollution of the environment. Polluting factors include chemical, biological pollution, electromagnetic fields, ionizing radiation, x-rays, acoustic noise, vibration, etc. In order to measure the impact of these factors on people and the environment a lot of instruments and measurement systems have been developed. But most of them are not available the ordinary user of a modern computer because of their large size, unique and / or high cost. One of the common problems is the lack of real information about the state of the environment and / or the lack of availability to the society.

On the other way, the spread of a variety of mobile devices with Internet connection (since 2011 their number has already exceeded the billion), and a variety of smart sensors and controls, has created a unique environment for the organization as a total control over the parameters of the environment, so and the human body. It allows dealing more effectively with environmental problems as well as the many challenges associated with telemedicine and biometrics [5].

The implementation of supersensory computer prototype

Some compact and low cost experimental models of the SSC were developed. A large number of parameters measured with reasonable accuracy is the main ad-

vantage of the SSC. In the development process it was assumed that supersensory computer as an intelligent sensor device, which includes a large number of miniature sensors, microprocessor, memory, and communications (figure 1), should initially be considered as part of a distributed autoconfigurable supersensory computer wireless network (SSN) consisting of SSC and small intelligent sensor devices (figure 2). In this regard the prototype of supersensory computer has multiple interfaces to exchange data with other devices and the central server: USB, serial port, Bluetooth and GSM modem. It also includes a built-in non-volatile memory, real time clock and allows you to connect external storage devices such as memory cards.

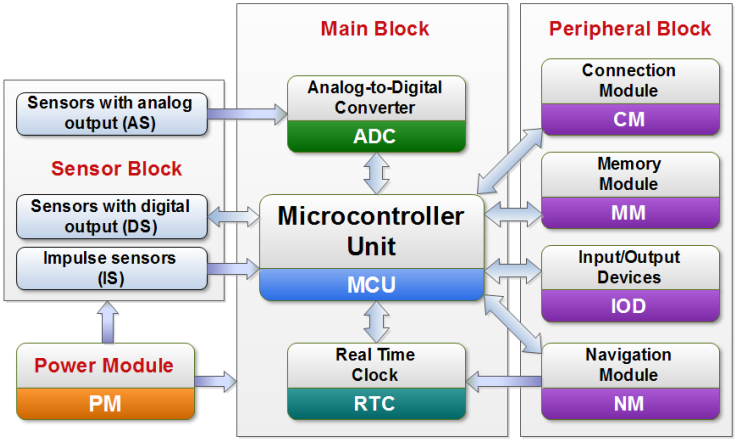

Figure 1. Hardware architecture of an experimental prototype of supersensory computer

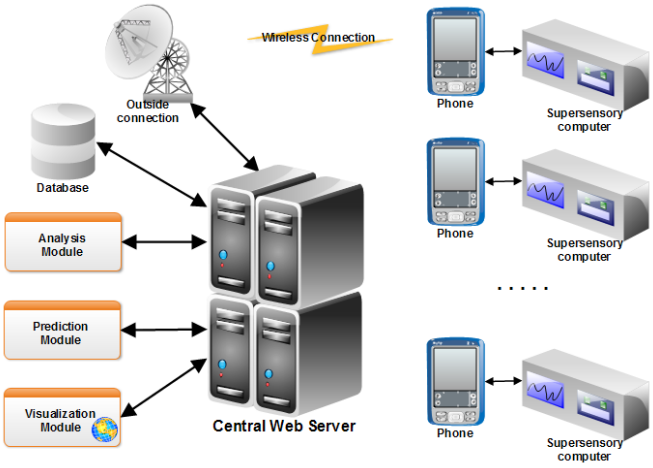

Figure 2. Architecture of supersensory network based on mobile supersensory systems

The SSC is powered by the built-in lithium-polymer battery, an AC adapter or a port USB.

In the near future it is planned to equip the supersensory computer by converters of bioelectrical potentials for ECG and EEG, as well as sensors in body temperature, heart rate, blood pressure, PCG and VCG.

Now the current experimental version of the SSC prototype [1, 2] is compact enough to be considered as a mobile and functional enough to hold all of the experimental researches. In the future it is planned to implement SSC in the form factors of tablet computers and mobile phones.

Accuracy of measurements and calculations in modern computers

In modern computer systems, it is possible to measure and use a variety of different parameters of objects, processes and environment [1, 2, 3].

Main parameters selected at this stage for measuring and processing by supersensory computer are temperature (-55...+125 °C), relative humidity (0...100 %), atmospheric pressure (300...1100 hPa), illuminance (0...70000 Lux), mechanical vibrations (-16...+16 g (3 axes)), acoustic noise (including ultrasonic noise, 20...150 dB), magnetic field (0...1000 Gauss), ionising radiation (0...100000 μR/h) and electromagnetic radiation (0...4000 μW/cm^2).

It should be noted that for most of the measured parameters the measurement accuracy is relatively low. This means that the presentation of the measured values in floating point format in a normalized mantissa really be credible only 2-8 digits. The majority of today's floating-point calculations, including calculations in microcontrollers, directly processes the measured signals with at least 32-bit precision. When transferring the measured values of the standard floating point accuracy, the information about the original precision is lost and not accounted for in the calculations. In some cases, this can significantly distort the subsequent results.

In addition, the feature of the modern floating-point calculations is the existence of situations in which a material misstatement in the results may be invisible to the user and appear in the most unexpected places [6, 7, 8, 9].

Both of these factors indicate a lack of reliability of modern measurements and calculations in floating point format, that the mass usage greatly increases the risk of cases of unacceptable distortion of the results.

Postbinary supersensory computer

Postbinary supersensory computer (PSSC) means, that the representation, storage, and usage in subsequent calculations of the measured values use postbinary data formats [10, 11]. The essence of these formats is to ensure that the coding bits is used by more than one bit, allowing a clear distinction between the representation of digits with uniquely defined values of the uncertain and valued bits. In most cases, there are enough 2 bits per digit, which allows to implement on the basis of tetralogic and tetracalculations [11] flexible capacity and normalized postbinary in-

terval calculations, that are best adapted to the specific conditions of measurements and calculations [12, 13].

Naturally, in many cases postbinary coding would be redundant. But a significant increase in the reliability of the results (you can even talk about a guaranteed accuracy) is worth the cost. Moreover, in the context of ever increasing degree of integration and reduce the integrated circuits cost, the additional costs of postbinary coding in modern conditions is fully justified, and the implementation of PSSC is relevant and timely [13].

Conclusions

Further research and development will focus on the following tasks:

1. Development of mathematical and algorithmic apparatus for integrated assessment and prediction of changes in the parameters of the environment and the operator's organism, including elements of postbinary computing.
2. Development of mathematical and algorithmic apparatus to search for correlations between changes in the external environment and internal environment of the human body, taking into account the requirements and opportunities of postbinary computing.
3. Development of client and server software for collection, analysis, synthesis and imaging information from supersensory computers (SSC) including the real time and the possibility of the information provided in postbinary formats.
4. Development of affordable, compact, equipped with the maximum number of sensors PSSC and / or a module that plugs into the existing and future mobile computing devices to be implemented in the standard form factor of today's mobile devices.

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